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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360

(12) 5p.

(11)

STEBG-TD (6) 7 OCT 1966

SUBJECT: Letter Report, Product-Improvement Test of the T53-L-11 Engine (Operational Suitability Testing of the Manual Acceleration Control), USATECOM [redacted] 4-5-0101-01

(16)

TO: See Distribution

1. References.

a. Letter, Lycoming Division of AVCO Corporation, 9 April 1965, subject: "CY 1964 Product Support and Product Improvement T53-L-11 Engine."

b. Message, AMCPM-IR-T 5-1168, Commanding General, US Army Materiel Command, 17 May 1965, subject: "Product Improved T53-L-11 Engine S/N LEO 9753."

c. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 1 June 1965, subject: "Test Directive, USATECOM Project No. 4-5-0101-( ), Product Improvement Test, UH-1B Items."

d. Letter, SMOSM-EAA, Headquarters, US Army Aviation Materiel Command, 11 June 1965, subject: "Product Improvement Test, UH-1B Helicopter."

e. USATECOM Project Transcript Sheet, AMSTE-BG, 18 June 1965, USATECOM Project No. 4-5-0101-01, Product Improvement Test of T53-L-11 Engine, S/N LEO 9753.

f. Letter, Lycoming Division of AVCO Corporation, 24 June 1965, subject: "Recommended Plan of Test for Manual Acceleration Control."

g. Plan of Test, USATECOM Project No. 4-5-0101-( ), "UH-1B Items Product Improvement Test," US Army Aviation Test Board, 8 October 1965.

h. Letter, STEBG-TP-A, US Army Aviation Test Board, 19 October 1965, subject: "Iroquois Test Coordination Meeting."

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i. Plan of Test, USATECOM Project No. 4-5-0101-01/06, Product Improvement Test for T53-L-11 Engine, 30 November 1965.

j. Message, AMCPM-IR-T 34447, Commanding General, US Army Materiel Command, 14 July 1966, subject: "UH-1 Test Coordination Meeting."

k. Plan of Test, USATECOM Project No. 4-5-0151-01, "Product Improvement Test of T53-L-11 Engine Product Improvement Items," US Army Aviation Test Board, undated.

2. Background.

~~a.~~ The UH-1( ) product-improvement program is a continuing attempt to correct those problem areas discovered during testing and field use of the helicopter, to improve the operational capabilities of the UH-1( ), and to reduce the support requirements of the helicopter.

~~b.~~ Among the problems discovered during early testing were engine overspeeds, compressor surge, and resulting engine over temperature when the standard fuel control was switched from automatic mode to emergency (manual) mode. To avoid this condition, the throttle twist grip must be retarded to achieve gas-producer speed of 70 percent prior to engaging the emergency governor. In the emergency mode, the throttle twist grip must be moved very slowly and precisely to avoid engine overspeeds and over temperatures. The test assembly has been modified to permit switch-over from automatic to emergency mode, with less possibility of exceeding engine limits, at any gas-producer speed at pressure altitudes up to 6,000 feet. In addition, because of the slower engine acceleration characteristics, the throttle twist grip may be moved more rapidly while in the emergency mode.

c. The product-improvement test of the modified manual acceleration control was directed by the Commanding General, US Army Test and Evaluation Command (USATECOM), in reference c as supplemented by references e and j.

d. The modified manual fuel control was initially installed on the test UH-1B Helicopter on 1 October 1965. Because of difficulties in operation, however, it was removed on 18 December 1965 and returned to the manufacturer for testing and repair. On 25 April 1966, the test system was reinstalled on the helicopter. The origin l problem still existed and the system was again removed and returned to the manufacturer.

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The problem was duplicated during manufacturer testing, and after modification the test system was reinstalled on the test helicopter on 18 August 1966, and the operational suitability test was initiated.

3. Objective.

To determine the operational suitability of the modified manual acceleration control.

4. Summary of Results.

a. Ground Operations.

(1) During engine starts with the twist grip in both flight idle and ground idle positions, the fuel control governor switch was placed in the emergency position when exhaust gas temperature (EGT) reached 400 degrees. Emergency starting procedures were followed. Positive control over fuel flow was available, and the capability of the test system to avoid hot starts was similar to that of the standard fuel control.

(2) During engine run ups, with the gas-producer speed stabilized at various speeds from 60 percent up to 70 percent, the governor switch was placed in the emergency position. Engine response was immediate with the gas-producer speed decreasing and stabilizing at approximately 40 to 48 percent. When the governor switch was returned to automatic, the gas-producer speed stabilized at the initial throttle setting.

(3) The governor switch was placed in the emergency position with power turbine speeds up to 6,600 r.p.m., and the collective pitch control in the full down position. Although immediate pilot reaction was necessary to prevent overspeeds of the power turbine and rotor, no unusual pilot techniques were required. Delays of 1.5 seconds resulted in maximum rotor operating r.p.m. EGT control was not a problem.

(4) The times for the engine to accelerate when the throttle was moved rapidly from a stabilized position to full open, with the governor switch in normal position and emergency position, were as follows:

Gas Producer R.P.M. (percent) From	To	Normal (seconds)	Emergency (seconds)
40*	80	N/A	21.5
40*	85	N/A	22.1
62**	80	2.5	5.3
62**	85	3.2	6.0
70	80	1.6	2.9
70	85	2.0	3.4

b. Flight Operations.

(1) The governor switch was placed in the emergency position during hovering flight, takeoffs, approaches, and landings. The requirement for rapid pilot reaction was greatest during approaches. With the power turbine at 6,600 r.p.m. and collective pitch reduced for descent, throttle reduction had to be immediate to prevent exceeding engine limitations. Reaction time did not have to be as rapid during hovering flight or takeoffs at high power settings. No unusual pilot techniques were required to continue the manuevers following switch-over from normal to emergency. The power turbine speed and EGT were less sensitive to changes in throttle position with the test system than with the standard fuel control.

(2) During stabilized climbs at various rates of climb from 100 feet per minute (f.p.m.) to 1100 f.p.m. and gas-producer speeds from 85 to 95 percent, the governor switch was placed in emergency position. Pilot reaction time had to be most rapid during climbs at the lower power setting to prevent exceeding engine limitations. No unusual techniques were required to continue climbing flight, and the power turbine speed and EGT were not excessively sensitive to changes in throttle position.

(3) The governor switch was placed in emergency position during various stabilized cruising airspeeds from 60 knots indicated

*Throttle twist grip set at flight idle detent with governor in emergency.

**Throttle twist grip set at flight idle detent with governor in normal.

airspeed (IAS) to 100 knots IAS (6,600 r.p.m. power turbine speed at pressure altitudes of 1,000; 3,000; and 6,000 feet). No unusual pilot techniques were required to continue cruising flight or to avoid exceeding engine limitations. Pilot reaction time was least critical during cruising flights at high power settings. Power turbine speed and EGT were not excessively sensitive to changes in throttle position.

(b) During stabilized descents at various rates of descent [illegible] to 1,[illegible] f.p.m. with 6,600 r.p.m. power turbine speed, the governor switch [illegible] placed in the emergency position. Pilot reaction time was most critical at the lower collective pitch control settings and immediate reaction was necessary to prevent exceeding engine limitations. [illegible] unusual techniques were required to recover from the descent, and power turbine speed and EGT were not excessively sensitive to changes in throttle position.

(c) During stabilized autorotative descents, the governor switch was placed in the emergency position. No unusual techniques were required to [illegible] to straight and level flight. Pilot reaction [illegible] not critical because movement of the governor switch to [illegible] throttle at flight idle resulted in a decrease in gas-producer r.p.m. [illegible]. The power turbine speed and EGT were not excessively sensitive to changes in throttle position. Power recoveries with [illegible] governor [illegible] required approximately 500 feet altitude be[illegible] to [illegible] ation programmed by the test system.

c. [illegible] functions of the test fuel control occurred during either the ground checks or the 20 hours of flight testing.

d. Installation and maintenance instructions were not furnished with the test system.

5. Conclusion

The modified manual acceleration control is operationally suitable for Army use on the T53-L-11 engine installed in the UH-1B Helicopter.

6. Recommendations. It is recommended that:

a. Installation and maintenance instructions be developed for the test system.

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b. Product-improvement testing (USATECOM Project No. 4-5-0101-06) be continued on the test system to determine durability.

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